Shape coexistence in Pb-Rn nuclei studied by particle decay spectroscopy

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Shape coexistence is a well-established phenomenon in the vicinity of the Z=82 shell closure. Unfortunately, due to low production cross-section and high background from fission, the most neutron-deficient nuclei cannot presently be reached with in-beam techniques (the current cross-section limit for this method is $\sigma \sim 100$ nb).

On the other hand, $\alpha$ decay has proven to be a very sensitive tool to study shape coexistence in nuclei, providing information on both parent and daughter states involved in the decay. Furthermore, nuclei with production cross-sections in the sub-nanobarn region become accessible.

This contribution reviews the results of the recent experiments at the velocity filter SHIP (GSI, Darmstadt) and at some other facilities around the world, in which a number of very neutron-deficient nuclei with Z=83-88 were studied. In most of these experiments complete fusion reactions at beam energies close to the Coulomb barrier were used, followed by particle detection with various detection systems.

In particular, in the experiments at SHIP two new very neutron-deficient isotopes $^{186,187}$Po were identified [1] and decay properties of $^{188-192}$Po were re-studied in detail. A striking observation from our experiments is the strong retardation of the $\alpha$ decay of the even-even $^{186,188,190}$Po isotopes in comparison with the Geiger-Nuttall law, which stipulates a linear decrease of the half-life as a function of the decay energy: $\log(T_{1/2}) \sim Q^{-1/2}_\alpha$. For example, in $^{186}$Po the measured half-life is more than two orders of magnitude longer in comparison with the expected value from the Geiger-Nuttall law using a linear fit for the heavier isotopes $^{196-210}$Po. The observed effect is even stronger than the deviation from systematics when crossing the N=126 neutron shell.

In this contribution we will link the observed behavior to the configuration change between the parent Po and daughter Pb nuclei close and beyond the neutron mid-shell at N=104.

The results of the experiments at SHIP aimed at spectroscopic studies of the lightest Rn isotopes will be also discussed.

References